Homework Set 4: Focal Mechanism Solutions

1. The figure below shows focal mechanism solutions for three earthquakes. The shaded areas represent the compressional regions in first arrivals at seismograph stations. The letters P and T refer to the compressional and extensional strain axis orientations, respectively.

A. 

B. 

C. 

a) Draw the lines onto the fault plane solutions to show the orientations of the two fault planes in each double-couple solution. Don’t forget, fault planes always intersect the edges of the circle at two points that are exactly on opposite sides of the circle, 180° apart. (6)

b) If there is any strike-slip motion on any of the faults, indicate this using arrows along the fault lines (i.e., indicate whether left-lateral or right-lateral). (4)

c) Use a table to document the following information for EACH of the six faults. Be sure to use the right-hand rule when determining the fault strike. (24)

I. fault strike (in degrees)
II. fault dip (in degrees)
III. dip direction (compass direction)
IV. fault type (if a strike-slip component exists, mention whether left-lateral or right-lateral)
d) One of the focal mechanism solutions above represents a major earthquake that happened along the San Andreas fault in California. Determine which of the solutions (A, B, or C) is most likely to represent the California earthquake. EXPLAIN YOUR REASONING! Then, decide which of the two faults in the solution you selected is the most likely fault that actually produced the earthquake. Again, EXPLAIN YOUR REASONING!

2. (a) Use the focal mechanism (aka moment tensor) data below to construct a focal mechanism diagram for the Mw 7.4 Izmit earthquake in Turkey in 1999. Use the circle provided on the attached sheet to create your focal mechanism. Your strikes must be plotted with 100% accuracy so use a protractor to find the right angle around the circle. Use your stereonet from class to determine the curvature of the fault plane on the focal mechanism. Your dip must be accurate to within 5º accuracy. Remember, dips increase away from the circle boundary (0º dip) towards the circle center (90º dips). For both fault solutions, the strike direction is given below using the right-hand rule. FP = fault plane.

Also, use the orientations of the principal strain axes to identify the shaded and unshaded quadrants of the focal mechanism solution. Plot the locations of these strain axes as points on your focal mechanism.  

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MOMENT TENSOR SOLUTION
Best Double Couple: Principal strain axes:
FP1: Strike=092 Dip=75 S T Azimuth= 049
FP2: Strike=183 Dip=88 W P Azimuth= 317

(b) What are the two types of faults (i.e., the sense of slip) that potentially produced the earthquake?  

(c) The earthquake occurred along the North Anatolian fault. Given this information, which fault plane solution is more likely to be the correct one, and why?

3. On the attached figure, seismograph locations are plotted on a lower hemisphere stereographic projections with respect to an earthquake epicenter at the center of the projection. Stations with compressive first arrival P-waves are shaded squares; dilatational first arrivals are open circles.

(a) Use this information to construct a focal mechanism solution using the double-couple assumption. Shade in the compressional areas. Remember, the two fault planes must divide up the compressional first-arrival quadrants from the dilatational first-arrival quadrants. The easiest way to do this is to figure out where the two lines should intersect the outside of the circle in order to separate the shaded squares from the open circles. Then determine how curved each line needs to be. Remember, any fault plane always intersects the edges of the circle at two points spaced 180º apart. Also, the two fault planes must be mutually perpendicular in 3-D space (try to picture it in your head to see if the two planes your drew obey this requirement).

(b) What are the strike, dip, dip direction, and slip sense of each fault that was potentially responsible for this earthquake?
Focal mechanism for Question 2:
Question 3:

Lower Hemisphere Stereographic Projection

First P wave arrival:
- Compressional
- Dilatational